

**DENTAL TRAINING DEVICE**Cross Reference to Related Applications

1                   The present application is a continuation-in-part of  
2                   prior U.S. application Serial No. 10/024,683 filed December  
3                   18, 2001 and entitled DENTAL TRAINING DEVICE, now abandoned,  
4                   which was a continuation-in-part of prior application Serial  
5                   No. 09/848,739 filed May 3, 2001 and entitled DENTAL  
6                   TRAINING DEVICE, now Patent No. 6,520,775.  
7

8

Background of the Invention

9                   The present invention related to dental equipment, and  
10                  more particularly, to teaching tools for the use of  
11                  endodontic apical location equipment.  
12

13                 During certain dental procedures, the pulp of the tooth  
14                 must be removed and other procedures must be performed on  
15                 the root canal. Persons training to become dentists must  
16                 learn how to properly remove such pulp and perform the other  
17                 necessary procedures. Precise location of the root apex is  
18                 vitally important for the correct endodontic treatment of a  
19                 tooth. Pulp tissue is richly vascularized and innervated  
20                 and is contained in the pulp cavity inside the tooth  
21                 including in the pulp chamber and in pulp canals in tooth

1 roots. The pulp canals are often referred to as root  
2 canals. If the endodontic procedure of extracting and  
3 cleaning the pulp tissue from a root pulp canal is performed  
4 at a length short of the apex, pulp tissue may remain in the  
5 canal. Failure to remove all pulp tissue may lead to  
6 infection and pain for the patient and necessitate  
7 additional surgery. If the endodontic procedure is  
8 performed beyond the length of the root apex, the reamer may  
9 penetrate into the periodontal ligament leading to pain and  
10 extreme sensitivity to the patient. Therefore, current  
11 endodontic procedures normally require the careful locating  
12 of the root apex at the base of the pulp canal before the  
13 reamer or other tools are used to enlarge the pulp canal.

14 Multiple methods are currently utilized to determine  
15 the location of the apex during an endodontic procedure on a  
16 live patient. One procedure is the use of x-ray radiographs  
17 of the tooth while a metal endodontic reamer is located in  
18 the root canal. This allows the dentist to visually compare  
19 the length of the metal reamer to the location of the end of  
20 the root to determine the location of the root apex. This  
21 method is often unreliable and not cost-effective.

22 A second method is to use an electrically aided apical  
23 position location. Certain electronic aids and methods of

1 their use include those described in U.S. Pat. No. 5,759,159  
2 to Masreliez, U.S. Pat. No. 5,211,556 to Kobayashi et al,  
3 and U.S. Pat No. 6,059,569 to Otsuka, all incorporated  
4 herein by reference. These patents describe apical position  
5 locators utilizing impedance measurements to determine the  
6 location of the apex that use electrical conductance. In  
7 the electrical conductance approach, an electrically-  
8 conductive probe is inserted into the root pulp canal and a  
9 second electrode is attached to the patient's body, such as  
10 by hanging a hook-shaped electrode from the patient's mouth.  
11 As the probe is inserted into the root pulp canal and  
12 advanced through the root pulp canal to the root apex, the  
13 electrical impedance between the probe and the electrode is  
14 continuously measured. The electrical impedance is greater  
15 when there is little conductance between the probe and the  
16 electrode, such as when the probe is in the pulp canal, and  
17 lower when there is greater conductance between the probe  
18 and the electrode, such as when the probe touches the tissue  
19 at the bottom of the pulp canal that is much more conductive  
20 than the pulp canal itself. Once the impedance lowers and  
21 reaches a predetermined range or value, the location of the  
22 apex is indicated and the depth of the probe is noted for  
23 future use with other instruments. The electrical approach

1 using impedance for determining apex location is currently  
2 the preferred and standard technique used in endodontic  
3 practice and taught in dental schools.

4       Instruction in the use of electrical apical position  
5 locators has generally required practice upon live patients  
6 in need of endodontic treatment. Performing endodontic  
7 procedures on healthy teeth is unethical and represents  
8 dental malpractice. Endodontic patients are often in pain  
9 prior to seeing the dentist, and are usually apprehensive  
10 about the endodontic procedure and less than enthusiastic  
11 about serving as subjects in dental instruction on the use  
12 of apical position locators. The additional pain which may  
13 be encountered, or the mere potential for such additional  
14 pain, results in few such patients volunteering to allow  
15 students to perform the procedure.

16       The number of endodontic procedures that a dental  
17 student or a doctoral student in general dentistry performs  
18 on live patients is severely limited by the number of  
19 willing participants in need of such procedures. Dental  
20 students and general dentists would benefit from additional  
21 training and instruction in the use of apical position  
22 locators in a realistic setting. In turn, the endodontic  
23 patient would benefit from the additional training received

1 by the practitioner.

2 Prior to this invention, no adequate surrogate for the  
3 live patient has been developed for instruction in the use  
4 of electrical apical position locators. U.S. Pat. No.  
5 5,503,562 described a transparent endodontic inspection  
6 block which allows the dental student to simulate the  
7 cleaning out the root pulp canal. The student utilizing the  
8 inspection block could look through the side of the  
9 inspection block and locate the root apex. This invention  
10 is not designed to train apex location techniques and does  
11 not represent realistic conditions of endodontic treatment.  
12 U.S. Pat. No. 4,137,633, issued in 1979, disclosed a  
13 resilient mass located at the apex of a block of transparent  
14 material to simulate the tactile sensation of the  
15 periodontal membrane located at the apex of a natural tooth.  
16 Thus, prior devices permitted students to visually locate a  
17 simulated apex through the addition of a resilient mass  
18 located at the apex. However, no known prior devices have  
19 disclosed providing a simulation of a live tooth and human  
20 tissue to practice using an electrical apical position  
21 locator.

22 Additionally, during training to do such procedures, it  
23 is important to have the procedure simulated on an actual

1 patient, as much as possible, so that the student can learn  
2 how to overcome problems of working in the patient's mouth.  
3 Therefore, it is also desirable to provide a training device  
4 that can be utilized for at least some of the student  
5 endodontic procedures and which simulates a live patient, as  
6 much as possible.

7       In addition to the need for a training device for use  
8 in teaching root canal procedures, it is also desirable to  
9 have such a device that can be used to teach other types of  
10 procedures such as how to treat dental decay and how to do  
11 crown and bridge procedures. Because training devices may  
12 be expensive for the student, it is preferable that the  
13 device allow the student to practice different types of  
14 procedures which preferably require somewhat different  
15 structure. Root canal procedures require real or artificial  
16 teeth having a root and with structure allowing electrical  
17 conductance. Crown and bridge work require a section of  
18 teeth wherein one or more is missing and real or artificial  
19 teeth can be modified to accept a bridge with a skin like  
20 structure over the gum, as it is important for the student  
21 to correctly interface the bridge with the skin. Dental  
22 decay procedures do not require a root or electrical  
23 conductance, but preferably utilizes real or artificial

1 teeth that are mounted in such a manner so as to simulate  
2 the interaction of the teeth with each other and with  
3 ligament tissue that normally holds such teeth in place.  
4 Each of these and other procedures are preferably performed  
5 on separate or different practice units to allow the student  
6 the best range of training.

7       Furthermore, it is desirable that the different  
8 sections be modular so that a student can preform one, two  
9 or all procedures within a single assembly. For example,  
10 when working on one procedure, all the individual modular  
11 inserts in an assembly may be designed for a single  
12 procedure to provide multiple locations to practice or such  
13 can be changed to provide modular inserts for multiple  
14 procedures for practice or testing. Because the individual  
15 modular inserts can be easily changed, when one is used and  
16 is not reusable, it can easily be replaced by another  
17 without requiring that the entire assembly be discarded.

18

#### 19                   Summary of the Invention

20       The present invention provides an improved device and  
21 method for the training of the use of an apical position  
22 locator. The invention uses a real or replicated tooth with  
23 a root and a root pulp canal (often referred to as a root

1 canal) having an apex at the root tip. Real teeth with pulp  
2 in the root canals are available from a supply of such teeth  
3 removed from patients for other reasons or from cadavers.  
4 In the present invention a student practices on a tooth set  
5 in a hard medium which mimics the electrical impedance of  
6 human tissue so that an electronic apical locator may be  
7 used. In a first embodiment, the tooth is mounted in a  
8 single, rigid conductive medium which mimics the  
9 conductivity and impedance characteristics of human tissue.  
10 An alternative embodiment uses a first highly conductive  
11 medium wrapped around the root tip to cover the apex of the  
12 tooth which is then surrounded by a second rigid medium so  
13 as to set the tooth in a fixture containing the second  
14 medium. The second medium may be less conductive and holds  
15 the tooth suitably for manipulation training purposes.

16 An electronic apical position locator has one lead  
17 connected to an endodontic probe or reamer and the other to  
18 an electrode blade extending from the medium. When the  
19 reamer is inserted in the root canal and extended so that  
20 the reamer tip contacts the conductive medium at the root  
21 apex, the electronic circuit of the apical position locator  
22 is closed, the impedance is measured and the apex is  
23 appropriately indicated by the apical position locator.

1           In another embodiment of this invention, the tooth is  
2   mounted in a manikin jaw that simulates a working human jaw.  
3   Preferably, the manikin jaw has sockets at various locations  
4   that are located whereat various teeth would normally be  
5   found. Each tooth upon which the student is to train is  
6   mounted in an electrically conductive medium that has a  
7   lower impedance than the training tooth root canal and which  
8   desirably has approximately the conductance or impedance of  
9   tissue found around the natural live root apex. A highly  
10   conductive medium is preferably placed in a protective  
11   sleeve and a second medium or matrix is placed about the  
12   tooth within a sleeve and then allowed to harden. The  
13   sleeve is sized and shaped to be received in one or more of  
14   the sockets. Preferably, the sleeve is held in place by a  
15   pin, such as a thumbscrew or similar fastener, that also  
16   acts as an electrical conductor in contact with the  
17   conductive material in the sleeve and in turn is  
18   electrically connected to an electrode of an apex location  
19   apparatus. The entire matrix may be a highly conductive  
20   medium or a less conductive medium may be used externally  
21   relative to the sleeve. Further, if the pin connects  
22   directly with the highly conductive medium in the sleeve,  
23   the remainder of the matrix does not have to be conductive.

1           A more detailed understanding of the invention will be  
2   obtained from the following description of the preferred  
3   embodiments taken in conjunction with the attached drawings.

4           This invention provides an actual or replicated human  
5   tooth with an electrically equivalent replicated human  
6   tissue medium, especially in a human form manikin, to  
7   provide a realistic simulator for training in the use of an  
8   electrical apical position locator. Patient volunteers do  
9   not normally clamor for dentists-in-training to practice  
10   root canals upon them, so this invention allows the dental  
11   student the opportunity to practice in a realistic  
12   environment, preferably with real teeth having pulp in the  
13   root canals thereof. The user may select a partially  
14   radiopaque electrically conductive medium, which allows the  
15   student to also simulate the determination of the location  
16   of the root apex through the use of an x-ray radiograph.

17          In yet another modification of the invention, the  
18   training aid is provided with modular inserts that mimic  
19   various portions of the jaw and which can be easily  
20   exchanged with other inserts that mimic the same portion of  
21   the jaw. In this manner, the inserts can include one or  
22   more units for training for particular procedures such that  
23   all of the assembled inserts may be for the same procedure

1 or for different procedures. Each insert can be easily  
2 replaced by another for the same or a different procedure.

3 Different inserts may be advantageous for many  
4 different procedures. For example, the inserts may be  
5 especially designed to act as an instruction aid for root  
6 canal procedures, repair of dental decay procedures, for  
7 crown and bridge procedures or for other procedures. The  
8 root canal procedure inserts are preferably of the type  
9 described above with the added feature of providing a common  
10 electrical conductor for the entire insert support structure  
11 so that electrical conductance will be available whether  
12 none, one or multiple inserts are for root canal procedures.  
13 The dental decay procedure inserts preferably include  
14 structure to allow teeth to be mounted in a matrix that  
15 mimics the setting of live teeth relative to ligaments that  
16 support and hold live teeth, so the student more closely  
17 encounters the feel of working on live teeth, especially  
18 crowding by adjacent teeth and flexing under pressure. The  
19 crown and bridge procedure inserts preferably include an  
20 artificial skin layer that mimics a patient's skin, so that  
21 the student gains experience in mounting crowns and bridge  
22 relative to skin tissue.

23

1                   Objects and Advantages of the Invention

2           Therefore, the objects of the present invention are: to  
3   provide a training aid for dental students comprising a  
4   holder or fixture for holding a tooth in a solid medium or  
5   material that is at least in part approximately as  
6   electrically conductive as non-boney tissue found in humans  
7   that surrounds teeth so as to simulate the electrical  
8   conductivity or impedance found in such tissue and thereby  
9   allowing a student to perform practice root canal  
10   procedures, including practice with an electrical apical  
11   position locator, without need for living patients; to  
12   provide such a training aid wherein the fixture is an  
13   independent container partially filled with solid  
14   electrically conductive medium or material that simulates  
15   the electrical conductivity or impedance of human tissue  
16   surrounding teeth; to provide an alternative embodiment of  
17   such a training aid wherein the fixture includes a socket in  
18   a manikin that simulates a human jaw structure; to provide  
19   such a training aid wherein the sleeve is sized and shaped  
20   to fit in such a manikin socket to allow easy removal and  
21   cleaning after the training session is complete; to provide  
22   an alternative manikin training aid wherein teeth with a  
23   highly conductive media about the root tips thereof are

1 molded directly into the manikin; to provide such a training  
2 aid wherein a thumbscrew is used as a pin to secure such a  
3 sleeve in a socket and wherein the thumbscrew also functions  
4 as an electrode for the apical position locator; to provide  
5 such a training aid that includes a set of modular training  
6 inserts wherein such inserts can be exchanged for similar or  
7 different inserts to form a training assembly; to provide  
8 such a training aid that provides such inserts wherein each  
9 insert is especially adapted to particular procedures, such  
10 as treatment of dental decay procedures, root canal  
11 procedures and crown and bridge procedures; to provide such  
12 training aid wherein all of the inserts in a final assembly  
13 may be selected for training on the same procedure or for  
14 different procedures to meet the needs of the student using  
15 the training aid; to provide a method of training aspiring  
16 dentists in endodontic procedures using the aforementioned  
17 training aids such that the students become skilled without  
18 having to practice on live patients; and to provide such  
19 training aids that are easy to use, comparatively  
20 inexpensive to make and especially well suited for the  
21 intended purpose thereof.

22 Other objects and advantages of this invention will  
23 become apparent from the following description taken in

1 conjunction with the accompanying drawings wherein are set  
2 forth, by way of illustration and example, certain  
3 embodiments of this invention.

4 The drawings constitute a part of this specification  
5 and include exemplary embodiments of the present invention  
6 and illustrate various objects and features thereof.

7

8 Brief Description of the Drawings

9 Fig. 1 is a cross-sectional view of a training aid in  
10 accordance with the present invention.

11 Fig. 2 is a cross-sectional view of a first alternative  
12 training aid.

13 Fig. 3 is a cross-sectional view of the first  
14 alternative embodiment of the training aid shown in  
15 connection with an electronic apex locator.

16 Fig. 4 is a perspective view of a second alternative  
17 training aid in accordance with the present invention,  
18 illustrating a training procedure being performed and with  
19 portions broken away to show internal detail thereof.

20 Fig. 5 is an enlarged cross-sectional view of a sleeve,  
21 tooth and highly conductive medium during a first step in  
22 assembly of the second alternative training aid.

23 Fig. 6 is an enlarged cross-sectional view showing a

1 second step subsequent to the first step shown in Fig. 5 in  
2 the assembly of the second alternative training aid.

3 Fig. 7 is an enlarged cross-sectional view of the  
4 second alternative training aid showing a third step in  
5 assembly thereof.

6 Fig. 8 is an enlarged cross-sectional view of the  
7 second alternative training aid fully assembled and shown in  
8 a fragmentary manikin as shown in Fig. 4.

9 Fig. 9 is an exploded perspective view of a third  
10 modified training aid according to the present invention  
11 having a plurality of modular inserts wherein each insert is  
12 utilized for training a student with respect to a different  
13 dental procedure.

14 Fig. 10 is a perspective view of the third modified  
15 training aid with inserts assembled.

16 Fig. 11 is a perspective view of the third modified  
17 training aid showing the assemblage being prepared for and  
18 during specific dental training procedures.

19 Fig. 12 is a fragmentary cross-sectional view of the  
20 third modified training aid, taken along line 12-12 of Fig.  
21 10.

22 Fig. 13 is a fragmentary cross-sectional view of the  
23 third modified training aid, taken along line 13-13 of Fig.

1 10.

2

3 Detailed Description of the Invention

4 As required, detailed embodiments of the present  
5 invention are disclosed herein; however, it is to be  
6 understood that the disclosed embodiments are merely  
7 exemplary of the invention, which may be embodied in various  
8 forms. Therefore, specific structural and functional  
9 details disclosed herein are not to be interpreted as  
10 limiting, but merely as a basis for the claims and as a  
11 representative basis for teaching one skilled in the art to  
12 variously employ the present invention in virtually any  
13 appropriately detailed structure.

14

15 First and Second Embodiments

16 Referring to Fig. 1, the reference numeral 1 generally  
17 indicates a training device according to the present  
18 invention which is useful to create an effective simulation  
19 of a tooth in a patient, so that a student may practice  
20 using an electronic apical position locator. The training  
21 device 1 consists of a tooth 2 which may be an extracted  
22 human tooth or a replica, which is set in a fixture 3 and  
23 connected to an apical position locator 4, Fig. 3, as

1 hereinafter described. In more detail, an illustrated  
2 exemplary tooth 2 is a pre-molar with two roots 10, each  
3 with a root canal 11 ending at an apex 12 near the tip 13 of  
4 each root. Other tooth forms are equally suitable. In a  
5 live tooth, the root canal 11 is filled with nerve pulp  
6 tissue. Also, a live tooth is set into a periodontal  
7 ligament which surrounds the root 10 and acts as a barrier  
8 between the tooth root and the bone that holds the tooth.  
9 In a patient the periodontal ligament or tissue around the  
10 tooth is moist and electrically more conductive than the  
11 tooth, thereby enabling the use of an electronic apical  
12 position locator 4 which relies on the measurement of  
13 impedance to determine when the more conductive tissue is  
14 encountered and therefore when the apex is reached. When  
15 the measuring probe electrode approaches the apex, the  
16 magnitude of impedance or the phase angle of the impedance  
17 between the measuring probe and oral probe electrode starts  
18 to change. The detector identifies the apex when the  
19 designated range or the frequency of impedance is reached.

20 In the illustrated example, the tooth 2 is a "dead"  
21 tooth which has been extracted from a patient or cadaver and  
22 is not supported by a living periodontal ligament or other  
23 live conductive materials. As shown in Fig. 1, the tooth 2

1 is set in a container or fixture 3 which is selected for  
2 ease of manipulation by a student. Preferably, a single  
3 setting material 15 is selected which provides sufficient  
4 rigidity to support the tooth 2 during handling and during  
5 the practice of root canal procedures. Ideally, the  
6 selected material 15 should also replicate the range of  
7 impedance of live human tissue in order to provide an  
8 impedance in the range of the apex locator setting. Since  
9 there are many different types of apex locators on the  
10 market, a single conductive material having an impedance not  
11 in the range of live human tissue can also be used for some  
12 apex locators of simple design and it is foreseen that a  
13 conductive material could be selected for a specific  
14 locator. Generally, the selected material 15 should  
15 replicate the conductivity of live human tissue in order to  
16 provide an impedance generally matched to the impedance of  
17 live tissue. Because an electric apex locator of advanced  
18 design contains circuitry and components to measure the  
19 impedance of human tissue and then compare the impedance  
20 value to the impedance values obtained by a measuring  
21 electrode inserted into the root canal, a closer match of  
22 impedance between the material 15 and the circuit of the  
23 apical locator 4 in the locating of apex is normally

1 preferred. A suitable range for the volume resistivity of  
2 the medium 15, 20 and 22 supporting the tooth 2 in the  
3 fixture 3 is in the range from  $10^{15}$  to  $10^{-3}$  ohm/cm.

4 To obtain a suitable support medium, conductive  
5 material is mixed with different binders. Such a binder can  
6 be plastic resin, polymer resin, plaster, stone, clay etc.  
7 Various types and concentrations of conductive materials in  
8 the binder have been conceived and include carbon, carbon  
9 fiber, graphite, silver powder, metal or metal coated fiber  
10 or powder or flakes, silicon, silicon dioxide, germanium,  
11 selenium, conductive polymer and others in slight to  
12 significant concentrations. If a radiopaque support medium  
13 can be tolerated, then a high metallic content or radiopaque  
14 chemical such as barium sulfate or stainless steel fibers or  
15 powder are usable with a binder. If radio transparency is  
16 needed, then metallic content is limited and carbon or other  
17 non radiopaque materials are increased to a proportion  
18 balancing strength, conductivity and human tissue impedance.  
19 The attribute of impedance matching is intended to bring  
20 impedance values into a range sensed by the circuit of the  
21 electronic apex locator.

22 A second embodiment of the present invention is shown  
23 in Figs. 2 and 3 and uses two conductive medium components.

1 The second embodiment is essentially the same as the first  
2 embodiment described above except for a modification to the  
3 medium supporting the tooth and is thus numbered the same  
4 except for this medium. In particular, in the second  
5 embodiment, a first conductive medium 20 is applied to the  
6 root tip 13 to cover the apex 12, generally in a ball about  
7 the root tip 13. When applying the first conductive medium  
8 20 to the root tip 13, care is exercised so as not to pack  
9 the medium 20 into the canal 11, but to merely cover the  
10 apex 12 as it intersects with the root 10. The preferred  
11 material of the first conductive medium 20 is a water based  
12 or a highly conductive material. The first conductive  
13 material or medium 20 can be a mixture of water, alginate,  
14 agar, gum, clay or a highly concentrated carbon or metal  
15 powder that is a very good electrical conductor in plastics,  
16 especially acrylics, or a mixture with a calcium or sodium  
17 inorganic salt, such as calcium sulfate.

18 The tooth with its root tip coated with the first  
19 conductive medium is placed in a second conductive medium 22  
20 which fills the fixture 3 and which is initially soft or  
21 even liquid. The second conductive medium 22 is preferably  
22 then set or hardened to form a solid support for the tooth  
23 2. Settling can be accomplished by allowing the medium to

1 dry, where appropriate, allowing it to chemically set such  
2 as an epoxy or acrylic, heat setting the medium 22, where it  
3 is capable of being heat set, or the like. The second  
4 medium 22 is preferably mixed with a conductive element as  
5 mentioned before, typically a resin type material, so that  
6 it can hold the tooth 2 in place for handling and practicing  
7 root canal procedures, after being hardened or set.

8       The first conductive medium 20 and the second  
9 conductive medium 22 may possess radiopaque material, if  
10 training utilizes radiographs to simulate use in a real  
11 patient. Such radiopaque material may include material such  
12 as metal fibers, metal-coated fibers, carbonaceous material,  
13 metallized glass or barium sulfate, as a substantial  
14 component of the medium 22 in sufficient amount to produce  
15 radiopaqueness. The first conductive medium 20 and the  
16 second conductive medium 22 may possess materials of  
17 differing radiopacity to simulate the different radiopacity  
18 of the periodontal ligament and the bone in a patient.

19       Fig. 3 shows the training device 1 in connection with  
20 an apical position locator 4. To enable the training device  
21 1 to be utilized with the apical position locator 4, a  
22 measuring probe such as an endodontic reamer 25 is connected  
23 to the apical position locator 4 via leads 26 and a

1 connector, such as an alligator clip 28. The apical  
2 position locator 4 is connected to the conductive medium  
3 such as the second conductive medium 22 via lead 30 and a  
4 connector such as an alligator clip 32, connected to an  
5 electrode or probe 34 set in second conductive medium 22.  
6 In the illustrated example, apical position locator 4  
7 indicates the closure of an electronic circuit when the  
8 endodontic reamer 25 contacts or almost reaches the  
9 conductive medium 20 at the apex 12. Then the resistance or  
10 impedance of these materials are measured, compared and  
11 calculated based on the pre-set formula in the apex locator.  
12 A final reading will indicate reaching the apex by the tip  
13 of the dental reamer. Normally, the apical position locator  
14 possesses sufficient sensitivity that it can determine the  
15 distance between the tip of the endodontic reamer 25 and the  
16 apex 12 and the locator provides a visual readout of that  
17 distance.

18 In the practice of the invention, a tooth such as an  
19 extracted human tooth 2 is used to train a user by placing  
20 the tooth 2 into a container or fixture 3 and supporting the  
21 tooth 2 therein by a conductive medium, such as the single  
22 medium 15 shown in Fig. 1. Alternatively, a first  
23 conductive medium 20 can be molded around the root tip 13,

1 being careful not to enter the canal 11. Next, the tooth 2  
2 with first conductive medium 20 wrapped around the root 10  
3 is placed in second conductive medium 22 in the fixture 3.  
4 The second conductive medium 22 is allowed to set so that it  
5 firmly holds tooth 2 in place. The apical position locator  
6 4 is connected to the endodontic reamer 25 and the probe 34  
7 so that when the reamer 25 is placed in the root canal 11  
8 and the reamer tip contacts the first conductive medium 20  
9 or single medium 15 (Fig. 1) at the apex 12, the locator  
10 electronic circuit completes the measurement of electronic  
11 resistance or impedance and the apical position locator 4 so  
12 indicates. Importantly, the resistance of the conductive  
13 medium is selected so that the electronic apical locator  
14 measures the resistance.

15        Optionally, the training device may be utilized along  
16 with x-ray machines and radiographic film to simulate the  
17 verification of the location of the apex 12 through  
18 simulation of the relative radiopacity of the periodontal  
19 ligament and bone by utilizing differing levels of  
20 radiopaque materials in the first conductive medium 20 and  
21 the second conductive medium 22.

22        Various forms of conductive media may be used as  
23 desired including thermoplastic resins, acrylic, polymers

1 and plasters with fillers such as carbonaceous material or  
2 metal fibers or flakes.

### 3 4 Third Embodiment

5 Illustrated in Figures 4 through 8 is a third  
6 embodiment of a dental training device in accordance with  
7 the present invention that is generally represented by the  
8 reference numeral 100. The training device 100 has certain  
9 aspects that are similar to the devices that are illustrated  
10 and disclosed in the previous embodiments and reference is  
11 made to those embodiments for certain details such as  
12 materials of construction.

13 The training device 100 generally comprises a manikin  
14 110 having at least one socket 111 and, unlike the  
15 previously disclosed embodiments, includes a sleeve 112  
16 operably received in the socket 111 and within which a tooth  
17 113 is mounted in a generally solid matrix 114.

18 The manikin 110 is preferably a type of device which is  
19 sometimes also referred to as a typodont that is utilized in  
20 the training of dental students. The manikin 110 has an  
21 upper jaw or maxilla 120 and a lower jaw or mandible 121  
22 that are mounted on a support frame 122, such that the jaw  
23 120 can be articulated with respect to the jaw 121 in a

1 manner that is similar to that of a human jaw, so as to  
2 simulate a human jaw for purposes of training of a dental  
3 student. The jaws 120 and 121 have a plurality of real  
4 and/or simulated teeth 126 that are positioned about the  
5 facing surfaces of the jaws 120 and 121 in such a manner as  
6 to simulate the appearance of teeth in a typical human  
7 dental patient. The jaws 120 and 121 are constructed of a  
8 material that can vary, depending upon what is desired to be  
9 taught to the students, but which is typically a rigid or  
10 semi-rigid plastic that has the shape and appearance of the  
11 gums and mouth of a human.

12 As will be discussed below, the material of  
13 construction of the jaws 120 and 121 may in some cases be an  
14 electrically conductive material that has conductivity quite  
15 similar to the gums and mouth tissue of a human patient or  
16 may alternatively be constructed of a non-conductive  
17 material. The material of construction of the jaws may also  
18 be radiolucent or radiopaque depending on whether x-ray  
19 procedures are to be used. As is seen in Figure 4, the  
20 upper jaw 120 of the present embodiment is hinged on the  
21 support frame 122 and is biased to a closed position by  
22 springs 128 wherein the teeth 126 of the upper jaw 120  
23 engage similar teeth of the lower jaw 121. This simulates a

1 patient with a mouth that can be opened and in which a  
2 student must work to perform procedures using the device  
3 100.

4 The sockets 111 are provided in the jaws 120 and 121 at  
5 locations where it is desirable to provide training to a  
6 student learning endodontic procedures. In the illustrated  
7 embodiment such sockets 111 are provided in the lower jaw  
8 near the rear where a large molar would be normally located  
9 and which is illustrated by broken away portions in Fig. 4.  
10 Sockets 111 are also provided in other locations such as are  
11 illustrated in the upper jaw 120 where somewhat more forward  
12 teeth are normally located. A training procedure is  
13 illustrated in Figures 4 to 8 with respect to an upper jaw  
14 socket 111, such as is shown in Fig. 4. Each socket 111 is  
15 sized and shaped to receive a sleeve 112 snugly therein.  
16 Each of the sockets 111 has a shape that is somewhat in the  
17 form of a hollow truncated cone and is accessible from the  
18 rear of each jaw 120 and 121 opposite the teeth 126 (see  
19 Fig. 4).

20 As is best shown in Figs. 5 through 7, each sleeve 112  
21 has a general truncated conical shape with a thin wall 129  
22 and has a hollow interior so as to form a cavity 130 with an  
23 open upper end 131 and open lower end 132. The cavity 130

1 has an interior surface 133. The sleeve 112 is sized and  
2 shaped to receive a tooth 113 and combined form an insert  
3 134. Such an insert 134 is shown in phantom lines in Fig. 8  
4 prior to placement in the socket 111 wherein the insert is  
5 shown in solid lines.

6 As has been described with the previous embodiments,  
7 the tooth 113 is preferably a human tooth that has been  
8 removed from a live patient for some other reason or is a  
9 tooth that has been harvested from a cadaver. In certain  
10 instances where a human tooth is unavailable, an artificial  
11 tooth that is sized and shaped to mimic a real tooth may be  
12 used. Such a tooth 113 includes a pulp chamber 137 and at  
13 least one root pulp canal or root canal 138 that extends  
14 along each root 139 of the tooth 113. Normally, such a  
15 tooth 113 would include pulp 141 intact in the root canals  
16 138 and pulp chamber 137. The root canals 138 containing  
17 the pulp 141 extend to an apex or tip 143 of each root 139.

18 The practice tooth 113 extends outwardly from the  
19 sleeve 112 such that a crown 146 of the tooth 113 is exposed  
20 and the tooth roots 139 are located within the sleeve 112.  
21 The tooth 113 is snugly and rigidly held in its associated  
22 sleeve 112 by the matrix 114. In the present embodiment,  
23 the matrix 114 has two components 148 and 150.

1           The first matrix component is a relatively good  
2   electrical conductor that is chosen to simulate the  
3   electrical conduction found in human tissue in the ligament  
4   and gum surrounding a live human tooth. The highly  
5   conductive matrix component 148 can be any of the materials  
6   that have been discussed in the previous embodiments for  
7   such a component.

8           In the present embodiment the highly conductive  
9   component 148 is a malleable or semi-solid material that is  
10  molded about each root tip 143. Because the material is  
11  soft and can be stripped from the root 139 accidentally, a  
12  protector 149 is placed over the highly conductive component  
13  148. In the present embodiment the protectors are annular  
14  sleeves 151 that are placed over each tooth root 139, as is  
15  shown in Figs. 5 and 6. The highly conductive component 148  
16  is specifically designed to provide good conductance at each  
17  root tip 143. Each sleeve 151 is manually snugged against a  
18  respective root 139 and about the highly conductive  
19  component 148 to hold the latter in touch with a respective  
20  root tip 143. It is foreseen that other forms and shapes  
21  could be utilized for the highly conductive component 148  
22  such as a cup or the like and without a protector.

23           The second component 150 of the matrix 114 can be

1 several different types of materials depending on whether or  
2 not it is desired for the component 150 to also be highly  
3 conductive or for conduction to be transferred from the  
4 highly conductive component 148 to the locating device  
5 described below through some other structure. Consequently,  
6 it is foreseen that the matrix component 150 can either be a  
7 highly conductive material similar to that of component 148,  
8 a semi-high conductive material that would be useful in  
9 providing conduction between the component 148 and a locator  
10 or alternatively, may not be conductive at all.

11 It is important that the matrix component 150 be at  
12 least semi-solid and preferably rigid during usage of the  
13 device 1, so as to support the tooth 113 in position while  
14 procedures are being performed on the tooth 113. For this  
15 purpose, various thermally set materials or the like could  
16 be utilized wherein the component 150 is initially a resin  
17 or powder into which the tooth 113 can be initially pushed  
18 or embedded after which the component 150 is heat set and  
19 solidified. Alternatively the matrix component 150 may be a  
20 stick-type resin that forms a liquid when heated and which  
21 can be dispersed into the sleeve 112, such as is illustrated  
22 in Fig. 7, and thereafter allowed to harden by drying,  
23 chemical reaction, heating with subsequent cooling or the

1 like. It is foreseen that other types of matrix components  
2 may be used in accordance with the invention. For the  
3 purpose of dispersion, a heating gun 155, such as a glue  
4 gun, distributes drops or a stream of conductive liquid or  
5 gel material 156 into the sleeve 112 around the tooth roots  
6 139 which thereafter solidifies or hardens as matrix  
7 component 150.

8 A pin 160 is utilized to secure the sleeve 112 in a  
9 respective socket 111. While it is foreseen that in some  
10 instances, the matrix 114 could be placed in a socket  
11 directly without a sleeve 112, such a sleeve 112 is  
12 preferred as same allows for quick change out and reduces  
13 the time that would otherwise be required to clean the  
14 hardened matrix out of the socket.

15 The illustrated pin 160 is a thumb screw that has a  
16 threaded shank 163 and flat head 164. The pin 160 is  
17 received through openings 167 in the manikin jaws 120 or  
18 121, as is shown in Figs. 4 and 8. The threaded shank 163  
19 provides two functions. In particular, the shank 163 locks  
20 the sleeve 112 in position relative to a respective socket  
21 111 and also provides a metallic conductor that directly  
22 engages the highly conductive component 148 when assembled,  
23 as shown in Fig. 8. The head 164 also provides two

1 functions. The head 164 allows a grasping structure for a  
2 user to insert the pin 160 and further provides a surface  
3 that is comparatively shaped to receive an alligator clip  
4 171, as will be discussed below.

5 It is foreseen that the tooth 113 can be inserted into  
6 the matrix 114 in the sleeve 112 in a number of ways, but  
7 one alternative is shown in Figs 5 to 7. In particular, the  
8 crown 146 of the tooth 113 to be mounted is placed in an  
9 indentation 173 in a block 174 of wood, embedded in a putty-  
10 like material, or the like. The highly conductive matrix  
11 component 148 is placed over the root tips 139 and  
12 thereafter the root sleeves 149 are placed over the tooth  
13 roots 139 and the component 148. Then the matrix holding  
14 sleeve 112 is placed over the lower part of the tooth 113  
15 with the sleeve lower end 132 engaging an upper surface 175  
16 of the block 174. The liquid material 156 that forms the  
17 second matrix component 150 is then deposited in the sleeve  
18 112 so as to preferably cover the root tips 143, the  
19 conductive component 148 and the protectors 149, so as to  
20 secure the tooth 113 in the sleeve 112. The sleeve 112 with  
21 the tooth 113 secured therein is then placed in a selected  
22 socket 111 and the pin 160 is used to secure the sleeve 112  
23 in the socket 111. The pin 160 preferably also touches a

1    respective highly conductive component 148 in which case the  
2    remainder of the matrix 114 that is component 150 does not  
3    have to be electrically conductive. If the pin 160 is not  
4    positioned to touch the highly conductive component 148,  
5    then the matrix component 150 must also be electrically  
6    conductive.

7            After the sleeve 112 is placed in the socket 111, a  
8    student 170 connects an apical position locator 180 to the  
9    device 100. In particular the student 170 uses an elongate  
10   reamer or probe 181 that has a shaft 182 sized to extend  
11   through a selected root canal 138. The shaft 182 is a  
12   conductive metal and is electrically joined by an alligator  
13   clip 184 attached to a lead 185 or the like to the main body  
14   (not shown) of the locator 180. The alligator clip 171 with  
15   a lead 187 is attached to the pin head 164, as is seen in  
16   Fig. 4. After opening the tooth crowns 164 by a well known  
17   process, the student then practices finding the bottom of  
18   the root canal 138 in the manner previously described. In  
19   an endodontic procedure, the finding of the apex of the root  
20   canal 138 is accompanied by removal of the pulp 141 and  
21   enlargement of the pulp or root canal 138 to the depth  
22   determined by the above described procedure. Thereafter,  
23   subsequent root canal procedures are performed.

1           It is foreseen that when a patient has a tooth that has  
2   a metallic filling or crown extending into or near the pulp  
3   chamber or root canal, it may be necessary to use a probe  
4   that is insulated over at least the portion of the shaft  
5   that would engage the filling or crown. For this purpose  
6   part of the shaft may be coated with nonconductive material.  
7   It is also foreseen that a hook, eye or the like may be  
8   joined to and extend outward from the probe shaft to  
9   facilitate connection of the locator device and especially  
10   an alligator clip.

11           It is also foreseen the manikin may be constructed of  
12   conductive material as well as the entire matrix 114 in  
13   which case it is not necessary that the pin be conductive,  
14   but only that the locator lead hook onto or otherwise join  
15   with the manikin jaw somewhere therealong. It is also  
16   foreseen that the sleeve holding the tooth may be held in  
17   place by something other than a pin or set screw. For  
18   example, a cover hinged to the manikin or a moveable hook  
19   could be used to hold the sleeve in the manikin during  
20   training procedures.

21           It is foreseen that the highly conductive material may  
22   include a filler of conductive carbonaceous material,  
23   including furnace black, channel black, acetylene black,

1 graphite fiber and carbon fiber; conductive fiber materials,  
2 including aluminum, nickel, copper, iron and stainless steel  
3 fibers; and metal coated fibers, including metallized glass,  
4 metallized graphite and metallized plastic fibers;  
5 conductive metal powders, including metallic flakes, powder  
6 and milled or ground metallized glass; and other conductive  
7 materials, including conductive organic polymers, glues,  
8 sponges, epoxies, paints, alginates and the like. A binder  
9 for the highly conductive component may be chosen from  
10 thermoplastic resins, including acrylic, polyvinyl chloride,  
11 polypropylene, polyethylene terephthalate, polystyrene, abs  
12 (acrylonitrile butadiene styrene resin), polyphenylene  
13 ether, polycarbonate, styrene and ethylene vinyl acetate;  
14 polymers, including bis-gma, TEGAMA and HEMA; and others,  
15 including plasters, yellow stone, clay and the like.

16 The following radiopaque materials may be added to some  
17 embodiments: barium sulfate and substantial concentrations  
18 of metal fillers such as nickel, stainless steel and the  
19 like.

20 It is foreseen that a conductive portion of the tooth  
21 holding matrix can also be a mixture of conductive materials  
22 including water, glycerine and other conductors, especially  
23 a percentage of from about 1 to 80% by weight in combination

1 with a filler or gelatin selected from clay, silica, gum,  
2 agar, alginate and the like. Further, the conductive  
3 material is preferably water with sodium hypochlorite, EDTA  
4 (ethylenediaminetetraacetic acid), conductive aluminum  
5 compounds, conductive calcium and sodium salts, conductive  
6 carbonate compounds, conductive basic compounds and the like  
7 in a range from 1 to 80% by weight with the remainder being  
8 binder or miscellaneous fill.

9 The following examples are provided to illustrate the  
10 invention and are not intended to be limiting on the scope  
11 or interpretation of the claims:

1

2

## 5

6

7

8

10

11

12

13

14

16

1 Two other procedures were performed on each of the teeth to  
2 determine root length which were by x-ray measurement and by  
3 in vitro measurement. The results are provided in Table 1.

4

5 Table I

6 Test Result:

7		Root length	Root length	Root length by
8		in vitro in mm	by x-ray in mm	apex locator in mm
9	Anterior teeth	23	23	23
10	Two root bicuspid	20, 20	20, 20	20, 20
11	Three root molar	19, 19, 19	19, 19, 19	19, 19, 19

12

13 Example II

14 Matrix conductive components of compositions C and D  
15 were prepared and tests were performed in the same manner as  
16 in Example I. The Composition D was applied directly to  
17 each root apex and the Composition C was used to surround  
18 and support each tooth and around Composition D.

19

20 Composition C

21	Clay	70%
22	Carbon-coated fiber	30%

23

24

1  
2  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
16  
17  
18  
19  
20  
21  
22  
23  
24

Composition D

Agar	30%
Salt	10%
Water	55%
Oil	5%

Table II illustrates the results of testing:

Table II

	Root length in vitro in mm	Root length by x-ray in mm	Root length by apex locator in mm
Anterior teeth	23	23	23
Two root bicuspid	20, 20	20, 20	20, 20
Three root molar	19, 19, 19	19, 19, 19	19, 19, 19

Example III

Matrix conductive components of compositions E and F were prepared and tests were performed in the same manner as in Example I. The Composition D was applied directly to each root apex and the Composition E was used to surround and support each tooth and around Composition F.

1

2

3

## 5

6

7

8

9

## 10

11

## 17

18

24

1	<u>Composition G</u>		
2	epoxy		70%
3	conductive sponge		30%

4			
5	<u>Composition H</u>		
6	Glycerine		77%
7	Salt		5%
8	Water		15%
9	Carbopol		3%

10				
11	<u>Table IV</u>			
12		Root length	Root length	Root length by
13		in vitro in mm	by x-ray in mm	apex locator in mm
14	Anterior teeth	23	23	23
15	Two root bicuspid	20, 20	20, 20	20, 20
16	Three root molar	19, 19, 19	19, 19, 19	19, 19, 19

17			
18	<u>Composition I</u>		
19	Ground Stone		60%
20	Carbon Powder		40%

21			
22	<u>Composition J</u>		
23	Alginate		60%
24	Water		40%

1

Table V

2

3

4

5

6

7

8

9

10

11

12

13

14

15

16

17

18

19

20

21

22

23

24

	Root length	Root length	Root length by
	in vitro in mm	by x-ray in mm	apex locator in mm
Anterior teeth	23	23	23
Two root bicuspid	20, 20	20, 20	20, 20
Three root molar	19, 19, 19	19, 19, 19	19, 19, 19

The test results for each of the Examples I to V indicate that locating root length apexes utilizing devices in accordance with the invention have essentially the same accuracy as direct measurement (which cannot be accomplished in a living patient) and x-ray.

It is foreseen that teeth may be imbedded in the matrix by several different methods. The matrix can initially be powder, soft, pliable or the like and the tooth pushed into the matrix. The matrix may be poured about the tooth as seen in the third embodiment. Furthermore, it is foreseen that the highly conductive component of the matrix may be located only about the tooth root and surrounded by a second component or the highly conductive component may completely fill a sleeve sized for insertion in a socket or a container, or the highly conductive component may be a layer having less conductive material above and/or below the highly conductive component, including a thin layer of

1 matrix fixing material that forms a substantially solid  
2 layer of matrix near the top of the tooth.

3 As will be apparent to persons skilled in the art,  
4 various additional modifications, adaptations and variations  
5 of the foregoing specifically disclosed embodiment and  
6 method for training in the use of an apical position locator  
7 may be made without departing from the objectives and scope  
8 of the present invention. Various modifications and changes  
9 may be made to the embodiment disclosed herein by those  
10 skilled in the art and such are contemplated by the present  
11 invention and are to be understood as included within the  
12 spirit and scope of the appended claims.

#### 13 14 Fourth Embodiment

15 Illustrated in Figures 10 through 13 is a fourth  
16 embodiment of a dental training aid in accordance with the  
17 present invention and generally indicated by the reference  
18 numeral 200. The fourth embodiment includes elements of the  
19 first three and reference is made to the first three  
20 embodiments for greater detail.

21 The dental training device 200 includes a tray or  
22 structural support 203, three training inserts 204, 205 and  
23 206 and a securing plate 207.

1       The structural support 203 is generally in the shape of  
2   a human jaw and in conjunction with the inserts 204, 205 and  
3   206 provides a user with the feel of working on a human. It  
4   can be either an upper or lower portion of the mouth and can  
5   be used separately or in combination with a second unit in a  
6   manikin of the type shown in Fig. 4.

7       The support 203 includes a peripheral wall 210  
8   extending upward from a lower and generally flat base 211 to  
9   a contoured end 212. A central and rearward portion 214 of  
10   the base 211 extends upwardly and has a pair of spaced and  
11   threaded bores 216 that extend downward vertically from a  
12   top thereof. The remainder of the base 211 is covered by a  
13   relatively thin metal conductive plate 220 that is somewhat  
14   crescent or horseshoe in shape and which preferably receives  
15   all of the training inserts 204, 205 and 206 thereon in  
16   touching relationship. The plate 220 includes a metal  
17   conductive ring 225 that extends through and protrudes  
18   outwardly from the support 203. The plate 220 has an upper  
19   surface 228 that is below an upper surface 229 of the base  
20   portion 214.

21       The support wall 210 has an interior facing aperture or  
22   slot 230 for each insert 204, 205 and 206 that also face the  
23   inserts 204, 205 and 206 respectively when placed on the

1 support 203 and which are used for securing the inserts 204,  
2 205 and 206 in the support wall 210 as described below.

3 The present embodiment includes three inserts 204, 205  
4 and 206 although it is foreseen that two or more than three  
5 could be used in accordance with the invention. The  
6 illustrated inserts 204, 205 and 206 are designed to provide  
7 practice and instruction to a student training in dental  
8 procedures.

9 In the present embodiment, insert 204 is especially  
10 designed for training in repair of tooth decay procedures,  
11 insert 205 is designed for training in crown and bridge  
12 procedures and insert 206 is designed for training in root  
13 canal procedures. Each of the inserts 204, 205 and 206 are  
14 modular and can be replaced with other units that provide  
15 training for the same or different procedures. In this  
16 manner, the student can acquire inserts for a single aid 200  
17 device that can be used multiple times to teach different  
18 procedures and can be assembled in such a manner, as shown,  
19 to allow training or testing on multiple procedures at the  
20 same time or a plurality of training sites for a single  
21 procedure. In particular, in some uses, all of the inserts  
22 may be for the same procedures.

23 The insert 204 includes a base structure 235 that

1 simulates the right rear third of the lower jaw. It  
2 includes apertures, sockets or openings 238, 239, 240 and  
3 241 for teeth 250 to be used in training for treating tooth  
4 decay. The openings 238, 240 and 241 are designed to  
5 receive a single tooth 250 each. The opening 239 is wider  
6 than the others and receives multiple teeth 250, so that the  
7 teeth 250 therein can be set to simulate a close  
8 positioning.

9 A tongue 255 extends outwardly from the insert 204 and  
10 is shaped and sized to be received in one of the slots 230.  
11 Each of the openings 238, 239, 240 and 241 extend vertically  
12 part way through the insert 204. Glue or adhesive may be  
13 utilized to hold the tooth and a surrounding matrix 250 in  
14 the opening 238. A bore 261 extends through the base 235  
15 and allows the alternative use of screw to hold the tooth  
16 250 in the socket or opening 238. In use each of the  
17 openings 238, 239, 240 and 241 receive at least one tooth  
18 250 for performing repair of dental decay procedures as  
19 described before. The insert 204 has an inward facing lip  
20 257 near the bottom thereof for securing in place. A front  
21 260 of the insert 204 has a recess 261 therein. Teeth 250  
22 are placed in each of the openings 238, 239, 240 and 241 in  
23 the matrix 262 that gives slightly with pressure so as to

1     simulate the ligaments that are attached to live teeth.  
2     Preferably, the matrix 262 is at least partly constructed of  
3     rubber, silicon or the like to provide some degree of  
4     flexure. It is foreseen that the top of the matrix 262 can  
5     be solid with the tooth 250 and only the bottom of a  
6     flexible material.

7             The insert 205 is designed for crown and bridge work  
8     and in the present embodiment simulates the portion of the  
9     jaw normally holding the front 6 lower teeth of the mouth  
10    with the intent to use the two outer teeth for supporting a  
11    bridge. In particular, openings 266 and 267 are provided  
12    which receive and hold artificial or real teeth which are  
13    then ground by the student to provide supporting pegs 270  
14    and 271, as shown in Fig. 11. The student prepares a bridge  
15    275 with artificial teeth 276, 277, 278, 279, 280 and 281  
16    that then set on and are adhered to the pegs 270 and 271 in  
17    a conventional manner. A drape 284 of polyurethane,  
18    silicon, rubber or the like extends over the insert 205 and  
19    simulates the flexibility and structure of gum tissue, since  
20    it is important for the student to carefully interact with  
21    gum in crown procedures.

22             The insert 205 also includes an outward facing tongue  
23    290 that is positioned to fit in one of the slots 230 and an

1 inwardly facing lip 291. On opposite ends of the insert 205  
2 are position outward extending pegs 293 that are sized and  
3 shaped to be received in respective recesses in inserts 204  
4 and 206 such as recess 261 in insert 204.

5 The insert 206 simulates the left side of the lower  
6 rear third of the jaw and includes six openings 300, 301,  
7 302, 303 and 304 which are each sized to receive a tooth 308  
8 and do extend to the bottom 307 of the insert 206. Each of  
9 the openings 300, 301, 302, 303, 304 and 305 are sized and  
10 shaped to receive a unit such as unit 310 which includes a  
11 tooth 308 and a surrounding conductive media 311. The units  
12 310 are glued or otherwise affixed in the openings 300, 301,  
13 302, 303, 304 and 305. The teeth 308 are preferably real  
14 teeth having a root canal. The student performs root canal  
15 procedures on the teeth 308 in the manner described before.  
16 The top part of the media 311 does not need to be  
17 conductive, but the lower portion onto which the tooth 308  
18 root canal opens must be conductive between the tooth 308  
19 and the plate 220. The material of the media 311 engages  
20 the plate 220 so as to provide a conductive path between the  
21 bottom of each tooth root and the ring 225. The insert 206  
22 has a tongue 318 and a lip 319 similar to like structure  
23 found on the insert 204.

1           The securing plate 207 is sized and shaped to be  
2   secured to the base 211 using screws 324 set in apertures  
3   325 that are received in bores 216 in the support 203. The  
4   securing plate extends outwardly toward each insert 204, 205  
5   and 206 so as to cover the lips 257, 291 and 319 and so as  
6   to secure the inserts 204, 205 and 206 in the support 203  
7   when secured in place by the screws 324.

8           In use the various inserts are used in the manner shown  
9   in Fig. 11. An electrode 330 attached by an alligator clip  
10   331 to the conductive ring 225 when root canal procedures  
11   are performed in any of the inserts 204, 205 or 206. The  
12   inserts 204, 205 and 206 are changed out as needed for other  
13   procedures or when expended to start new procedures.

14          It is foreseen that each insert would have an inwardly  
15   directed extension plate that could be attached by a single  
16   thumb screw, by multiple screws or the like to the support  
17   203 and could replace the plate 207. Also, it is foreseen  
18   that an electrode could be attached to the plate 220 in a  
19   different manner than is shown which could replace the  
20   conductive ring 225.

21          It is to be understood that while certain forms of the  
22   present invention have been illustrated and described  
23   herein, it is not to be limited to the specific forms or  
24   arrangement of parts described and shown.